MARSHALL JOURNAL OF MEDICINE
Expanding Knowledge to Improve Rural Health.

Volume 2 | Issue 4 Manuscript 1074

2016

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DOI: http://dx.doi.org/10.18590/mjm.2016.vol2.iss4.11

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This case report is available in Marshall Journal of Medicine: https://mds.marshall.edu/mjm/vol2/iss4/11

Technique to improve cement penetration in total knee arthroplasty

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The authors have no financial disclosures to declare and no conflicts of interest to report.

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Abstract

In total knee arthroplasty, infection has always been cited as being the number one cause of failure. However, more recent studies have shown aseptic loosening as the top reason for failure now. Proper cement technique is an important factor in reducing the occurrence of aseptic loosening. Clean and dried bone are important in achieving rigid cement fixation. Subchondral cysts may be hidden below the cut bone surface and may interfere with cement interdigitation. During a recent total knee arthroplasty case, a simple technique was developed for identifying and clearing out these cysts. By only using the suction tip, the gentle sweeping of the cut-surface will excavate hidden subchondral cysts allowing for improved cement interdigitation.

Keywords

arthroplasty, total knee arthroplasty, cement penetration, suction

Introduction

Although infection has always been cited as being the number one cause of failure in total knee arthroplasty, current studies have shown aseptic loosening as the top reason for failure.[7,9] Proper cement technique is an important factor in reducing the occurrence of aseptic loosening. It is fully accepted that dry and clean bony surfaces are of utmost importance in achieving rigid cement fixation of total knee arthroplasty components.[6]

Subchondral cysts, while often removed with the tibial plateau cut, may extend down to the cut surface or be hidden in the marrow well underneath the cut surface.[4] These cystic lesions, when under areas of implantation, will interfere with cement interdigitation and should be cleared of their contents. While subchondral cysts at the cut surface of the tibia can be easily found, the lesions in the metaphysis of the tibia are difficult or impossible to localize on radiographs or intraoperatively without the use of the technique described. This discusses a simple technique that can allow the surgeon to quickly find and clear any cystic lesions that are directly adjacent to the cut surfaces to allow for optimal bone-cement interdigitation.

Technique

The index patient is a 71-year-old with severe degenerative joint disease of the left knee, which has caused pain for the last 10 years and is now unresponsive to conservative management. Past medical and surgical history were noncontributory except for chronic hepatitis C, left knee arthroscopy 10 years prior and left hip percutaneous pinning nearly 40 years prior. The patient had received approximately 20 cortisone injections over several years with the most recent injection 1 year prior to the total knee arthroplasty.

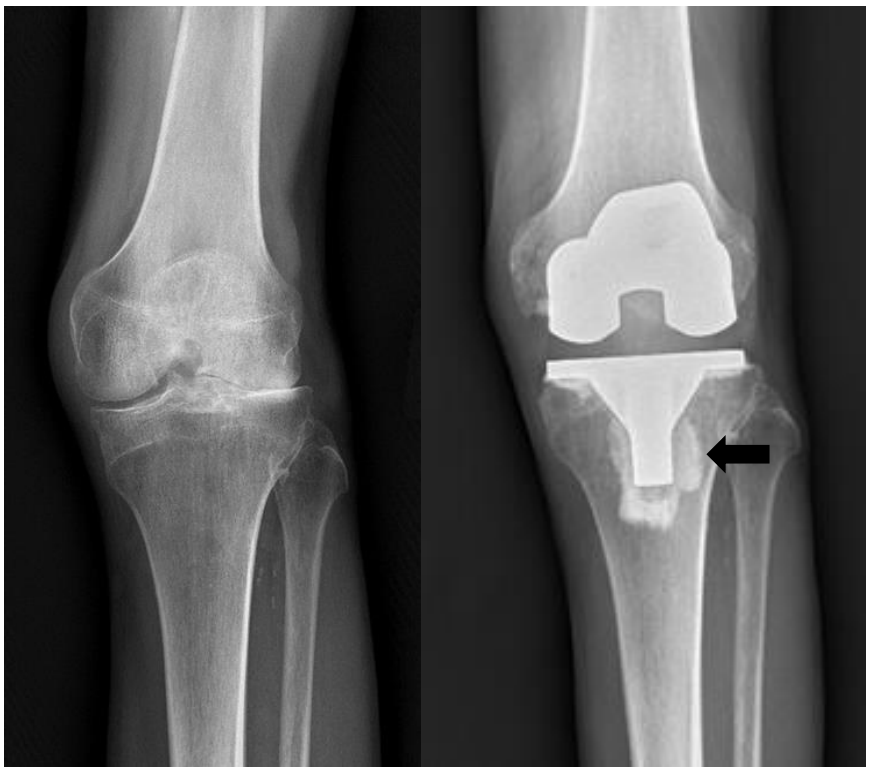
Clinical exam showed a tall, thin patient with antalgic gait. The left knee had severe crepitance and pain at both the patellofemoral and tibiofemoral joints. The left knee had slight valgus deformity and there was 1+ laxity to varus stress at 0 and 30 degrees. Range of motion of the left knee was 5-95 degrees with negative Stinchfield sign and straight leg raise tests. They had full strength throughout all extremities and the left dorsalis pedis and posterior tibial pulses palpable.

Preoperative radiographs showed severe degenerative joint disease of patellofemoral and tibiofemoral joints with valgus deformity. Radiographs also showed calcifications of femoral and popliteal vessels. Other than expected arthritic changes of subchondral sclerosis, no lucencies or abnormal lesions noted on preoperative films.

The patient underwent left total knee arthroplasty after being evaluated and cleared preoperatively by perioperative medicine and vascular surgery. After the tibial preparation, a sweeping motion of the suction was used against the walls of trabecular bone of the tibial intramedullary canal for inspection. The Yankauer suction tip was dragged from the bottom of the canal up towards the cut tibial surface with gentle, but consistent, pressure on the trabecular bone surface. This technique for tactile inspection of the canal walls was more purposeful than the routine use of the suction tip for keeping the canal surface dry. This sweeping motion against the trabecular walls opened up an adjacent cyst in the metaphyseal bone that resulted in the removal of approximately 10cc of serous fluid. Once the contents of this cyst were evacuated, the suction was used to check the remaining areas of trabecular wall, which were found to be sturdy without underlying cysts. The tibial component was then impacted in the usual manner. The remainder of the surgery and post-operative recovery were uneventful.

Post-operative radiographs showed excellent component fixation with the cement. The tibial cement extruded into the former cystic lesion to clearly define the border of the former lesion.

Figure 1. Pre-operative and post-operative AP radiographs of initial patient using described technique with the evacuated cyst filled with cement highlighted



In the subsequent month after this patient's surgery, two more patients had similar findings to the patient described above. In each of these patients, no preoperative radiographs hinted to a defined area of weakness or cystic structure. Use of only the Yankauer suction were used to uncover and evacuate these weak cystic areas of trabecular bone. Post-operative radiographs of these subsequent patients also showed the cemented outline of these areas found intra-operatively. Other patients on whom this technique was used, but did not have bone cysts found intra-operatively, showed no cement excursion around the tibial component on post-operative radiographs.

Figure 2. Pre-operative and post-operative AP radiographs of second patient showing the revealed cysts with the evacuated cyst filled with cement highlighted

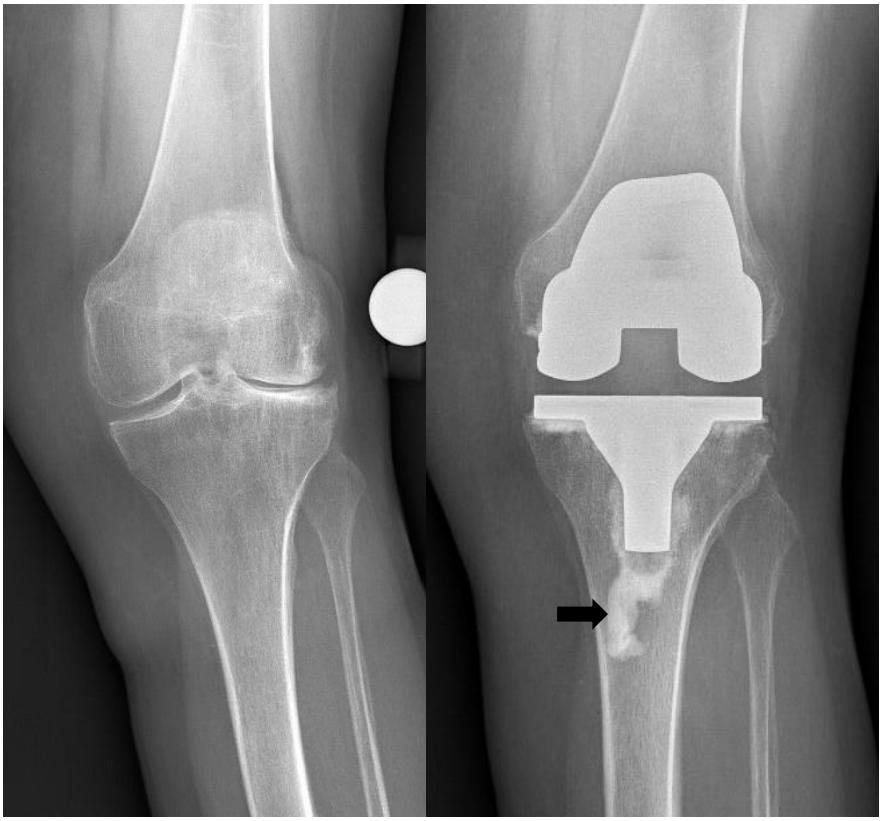


Figure 3. Pre-operative and post-operative AP radiographs of third patient showing the revealed cysts with the evacuated cyst filled with cement highlighted

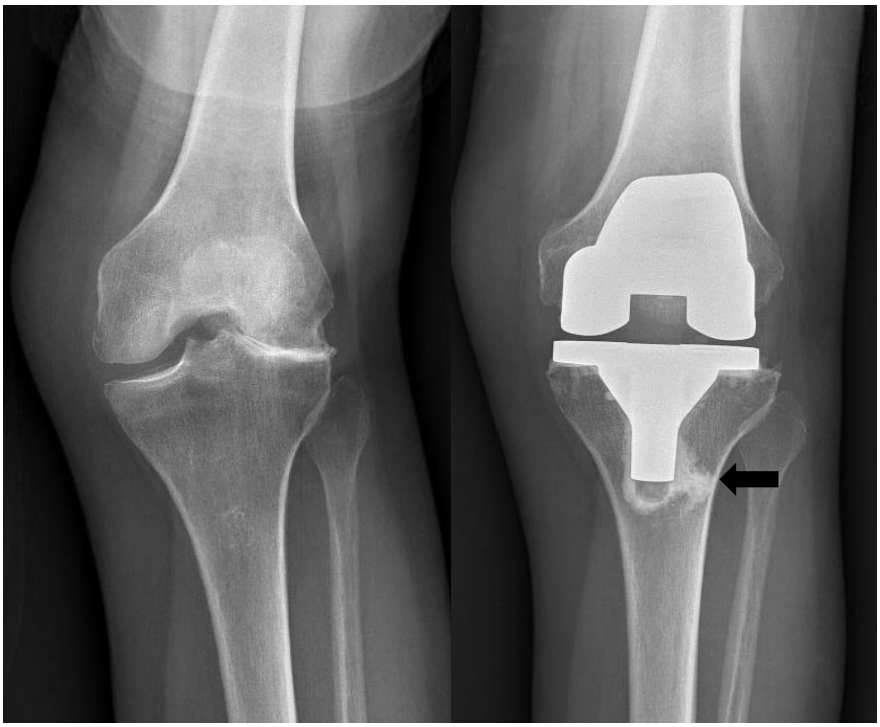
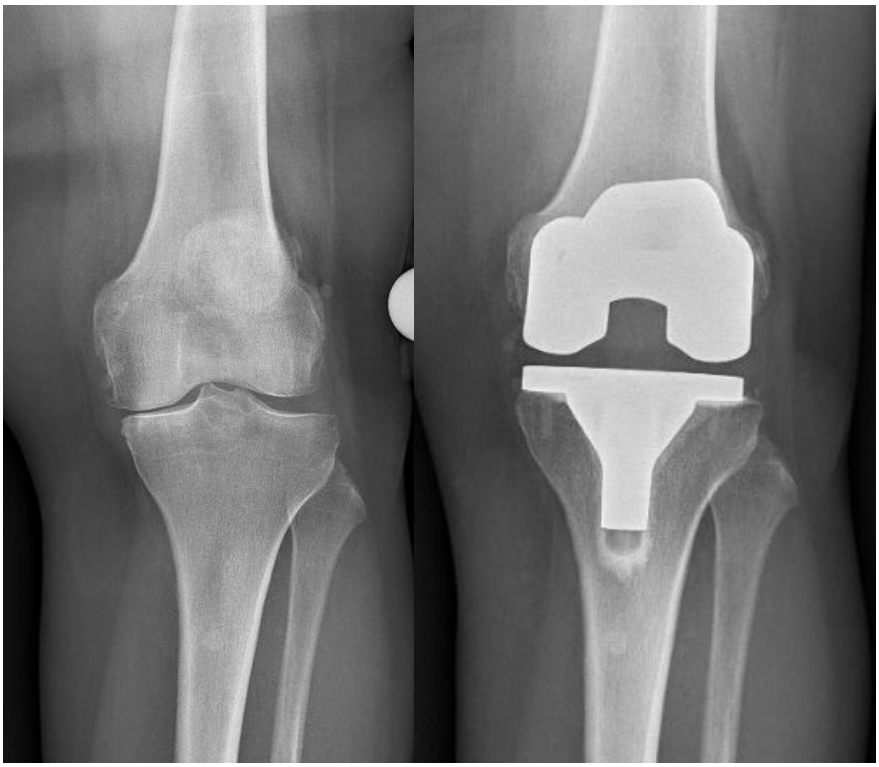


Figure 4. Pre-operative and post-operative AP radiographs of patient who did not have any cysts found for comparison



Discussion

There are a multitude of factors that determine the success of a total knee arthroplasty. With aseptic loosening being the leading cause of primary total knee arthroplasty failure, everyone agrees that adequate interdigitation of the cement with trabecular bone is vital in reducing the chance of aseptic failure. The optimal amount of interdigitation of the cement with trabecular bone has been reported between 3-5mm.[3]

There are several methods to improve the penetration of cement into trabecular bone, all of which require cleaned and dry bone. The bone that will interdigitate with the cement should also be sturdy. Any weak areas of trabecular bone should be removed and the bone should be cleaned with pulsatile irrigation.[5] The bone should be kept dry with suction and dry laps until cementing.

Using the suction tip to sweep the cut surfaces of tibial metaphysis from distal to proximal, the surgeon can feel the rigidity of these surfaces. Any weak areas of the trabecular bone surface should give way with gentle pressure revealing any underlying cystic lesion. Forceful longitudinal pressure with the suction tip should be avoided to avoid creating unnecessary defects. The purpose of this technique is to remove potential pockets that may significantly reduce the bone-cement interface strength. Compared to curettage, this technique is relatively atraumatic to the trabecular bone and should not create unnecessary defects in the tibial canal walls except when adjacent cysts are present.

It has been found that any fluid between the bone-cement interface can reduce the strength of that interface by up to 50%.[1,2] To reduce the possibility of any of these adjacent bone marrow lesions or cysts interfering with bone-cement interface, the technique described above has facilitated the discovery and evacuation of these lesions. While it has been debated whether full cementing or surface cementing of the tibial component is superior, we prefer the use of full tibial component cementing, as it has been found to reduce fatigue cracking at the interfaces.[8] While subchondral cysts at the cut surface of the tibia can be easily found, the subtle cysts in the metaphysis of the tibia are difficult or impossible to localize without the use of the technique described. Large cysts visible on radiographs can be removed by surgeon preference, however, this technique is suited for finding small cysts that are not visible on radiographs or by visualization. This technique is specifically suited for the tibial component of total knee arthroplasties due to the nature of the tibial stem cut being completely surround by trabecular bone, while other joint arthroplasties often rely on other methods of fixation such as press-fit or screw fixation.

Conclusion

Using the technique described above is a simple, yet effective method for ensuring optimal cement penetration and interdigitation with trabecular bone. The removal of directly adjacent cysts in the trabecular bone of the tibial metaphysis will prevent fluid from disrupting the bone-cement interface. Compared to the potential damage of curettage, gentle evaluation of the canal walls will help identify hidden cysts, while preserving unaffected surfaces of the canal. This technique could help reduce the possibility of aseptic loosening by improving the strength of cement fixation in the tibial component of a total knee arthroplasty.

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